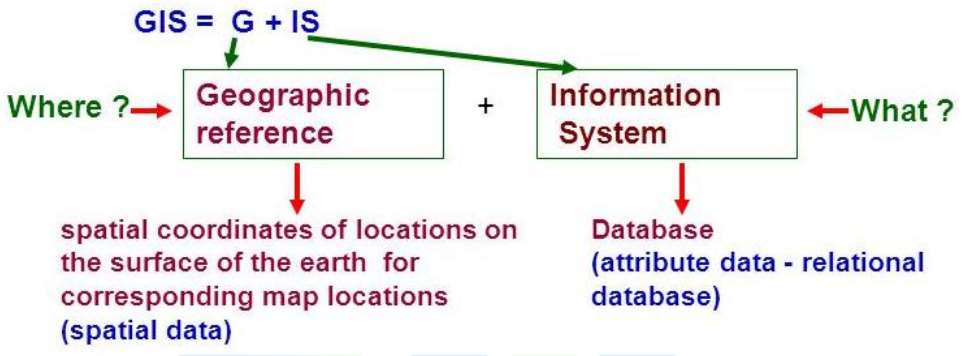
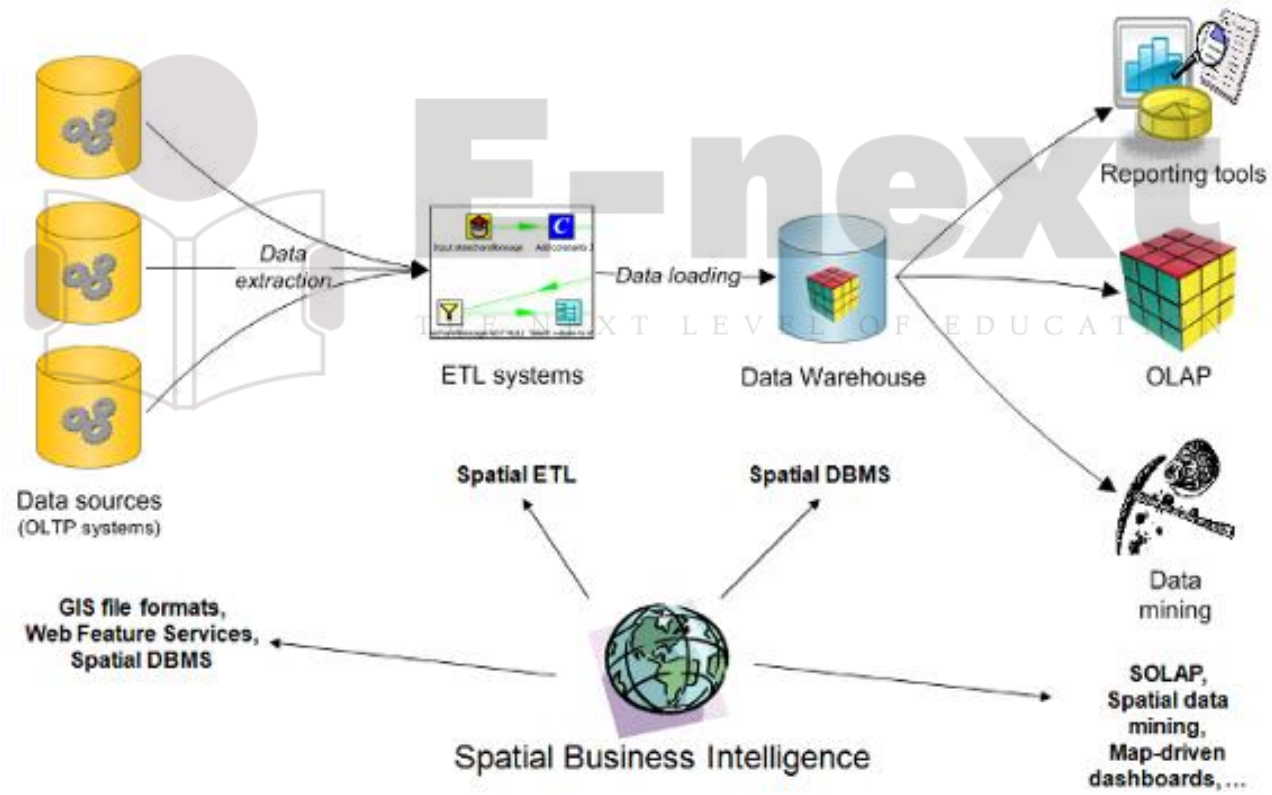
UNIT –III

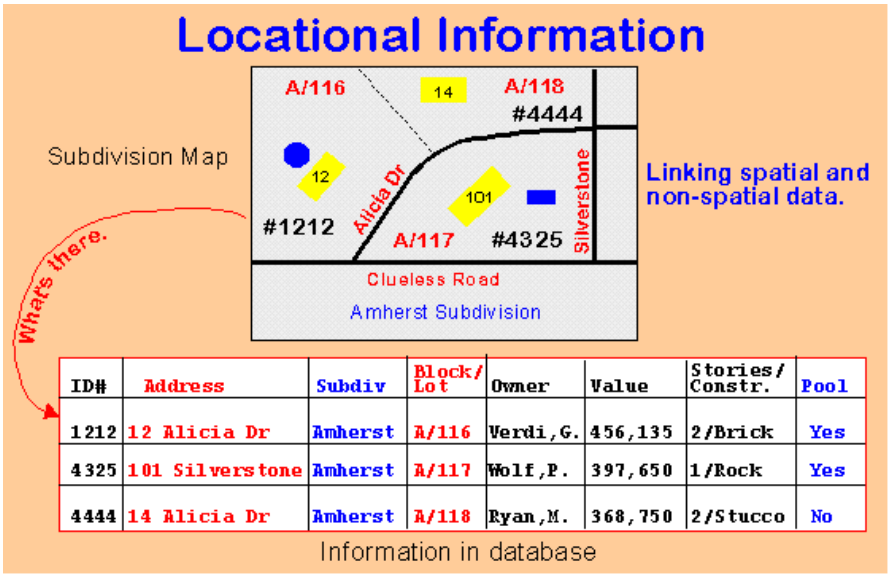
Attribute data input and data display:
Attribute data in GIS, Relational model, Data entry, Manipulation of fields and attribute data, cartographic symbolization, types of maps, typography, map design, map production



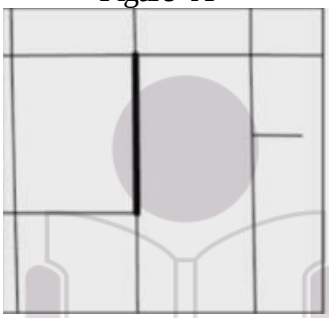


Attribute Data Management and Display

- GIS involves both spatial and attribute data :
- Spatial Data relates to the geometry of spatial features, and attribute data describe the characteristic of the spatial features.
- Figure A shown below shows attribute data such as street name, address ranges, and zip codes that are associated with each street segment.



- Figure A



FEDIRP	FENAME	FETYPE	FRADDL	TOADDL	FRADDR	TOADDR	ZIPL	ZIPR
N	4th	St	6729	7199	6758	7198	83815	83815

- The difference between spatial and attribute data is well defined with vector based features.
- The Georelational data model stores spatial and attribute data separately and links the two by feature ID. Figure B

Record	Soil-ID	Area	Perimeter
1	1	106.39	495.86
2	2	8310.84	508,382.38
3	3	554.11	13,829.50
4	4	531.83	19,000.03
5	5	673.88	23,931.47

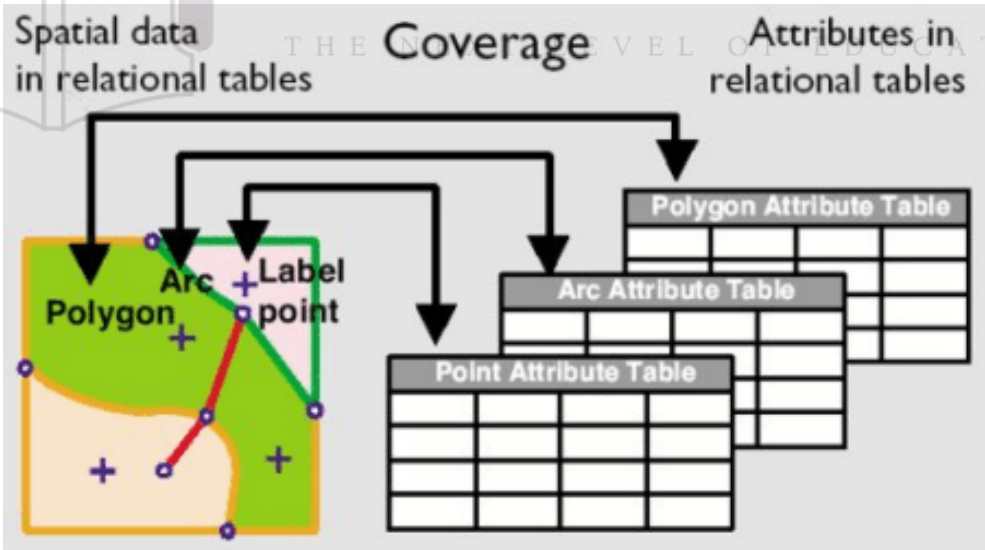
- The object based data model combines both spatial and attribute data in single system.
- Each spatial feature has unique object ID and attribute to store its geometry. Figure C

ObjectID	Shape	Shape_Length	Shape_Area
1	Polygon	106.39	495.86
2	Polygon	8310.84	508,382.38
3	Polygon	554.11	13,829.50
4	Polygon	531.83	19,000.03
5	Polygon	673.88	23,931.47

Attribute data in GIS

- Attribute data are stored in tables.
- An attribute table is organized by row and column.
- Each row represents a spatial feature, each column describes a characteristic, and the intersection of a column and row shows the value of particular characteristic for a particular feature.
- A row is also called a record or a tuple.
- A column is also called field or an item.

Type of attribute data



- There are two types of attribute data tables.
- The first type is called the feature attribute table, which has access to the spatial data.
- Every vector data set must have a feature attribute table.
- In the case of the georelational data model, the feature attribute table uses the feature id to link to the features geometry.

- In the case of the object based data model, the feature attribute table has a field that stores the features geometry.
- Feature attribute tables also have default fields that summaries the feature geometries such as length for line features and area and perimeter for area features.
- A feature attribute table maybe the only table needed if a data set has only several attributes.
- But this is often not the case. For example, soil map can have over 100 oil interpretations, soil properties, and performance data.
- To store all these attributes in a feature attribute table will require many repetitive and redundant entries, a process that wastes both time and computer memory.
- Moreover, the table will be extremely difficult to use and update.
- This is why we need the second type of attribute table.
- This second type of attribute table is non spatial, meaning that the table does not have direct access to the geometry of features but has a field that can link the table to the feature attribute table whenever necessary.
- Tables of non-spatial data may exist as delimited text files, dBase files, excel files.

Database management:-

- The essence of feature attribute and non-spatial data tables means that a GIS requires a database management system to manage these tables.
- A DBMS is a software package that enables us to build and manipulate a database.
- A DBMS provides tools for data input, search, retrieval, manipulation and output the use of DBMS has other advantages beyond its GIS applications.
- Often a GIS is part of an enterprise wide information system, and attribute data needed for the GIS may reside in various departments of the same organization.
- Therefore GIS must function within the overall information system and interact with other information technologies.

Type of attribute data

- One method for classifying attribute data is by data type.
- The data type determines how an attribute is stored in a GIS.
- Depending on the GIS package, the available data type can vary.
- Common data types are number, text, date and binary large object.
- Data type for numbers include integers (for numbers without decimal digits) and (floats for number with decimal digits).
- Moreover, depending on the designated computer memory, an integer can be short or long and a float can be single precision or double precision.
- BLOB store images, multimedia and the geometry of spatial features as long sequences of binary numbers.
- Another method is used to define attribute data by measurement scale.
- The measurement scale concept groups attribute data into nominal, ordinal, interval, and ratio, with increasing degrees of sophistication.
- Nominal data describe different kinds or different categories of data such as land use types or soil types.

- Ordinal data differentiates data by ranking relationship. For example, soil erosion may be ordered from severe to moderate to light.
- Interval data have known intervals between values. For example, a temperature reading of 70 degree Fahrenheit is warmer than 60 degree Fahrenheit by 10 degree.
- Ratio data are the same as internal data except that ratio data are based on a meaningful or absolute, zero value. Population densities are an example of ratio data because a density of zero is an absolute zero.
- In GIS applications the four measurement scales may be grouped into two general categories :
- Categorical data include nominal and ordinal scale, and numeric data include interval and ratio scales.
- Data types and measurement scales are obviously related.
- Character strings are appropriate for nominal and ordinal data.
- Integers and floats are appropriate for interval and ratio data depending on whether decimal digits are included or not.
- But there are exceptions. For example, study may clarify the potential for groundwater contamination, medium or low but may represent information may be present information as numeric data using a lookup table.

The relational model

- A database is a collection of interrelated tables in digital format.
- There are at least four types of data base design that have been proposed in the literature
  - **o flat file**
  - **o hierarchical**
  - **o network**
  - **o relational**

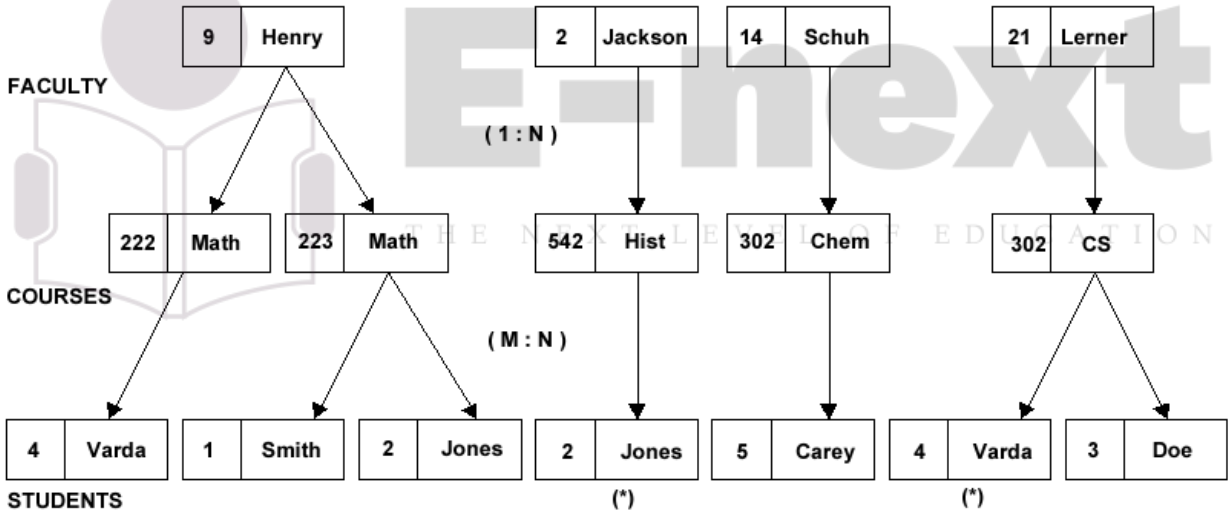
Generations of DBMS		
DBMS	**Characteristics**	**Problems**
Flat file system	-One large file contains all the data -Unique Identifier	-Data Redundancy -Access time is high -Wastage of memory -Not easy to add new fields
Navigational file system (Hierarchical & Network)	-Multiple files with different record structure -Record as master or parent -Each parent have many child records -Child records have children & parents	-Access via parent -Pointer structure is very complex e.g.- IBM's IMS
Relational DBMS	-Multiple files each with a different record structure -Tables can be related on a common record identifier	-High computational requirements if many joins -Tables & E-R carefully planned e.g.- ESRI's INFO, IBM's DBII, Oracle, Ingress, Sybase, Informix, SQL Server, MS-Access

- A flat file contains all data in a large table.
- A feature attribute table is like a flat file.
- Another example is a spread sheet with data.

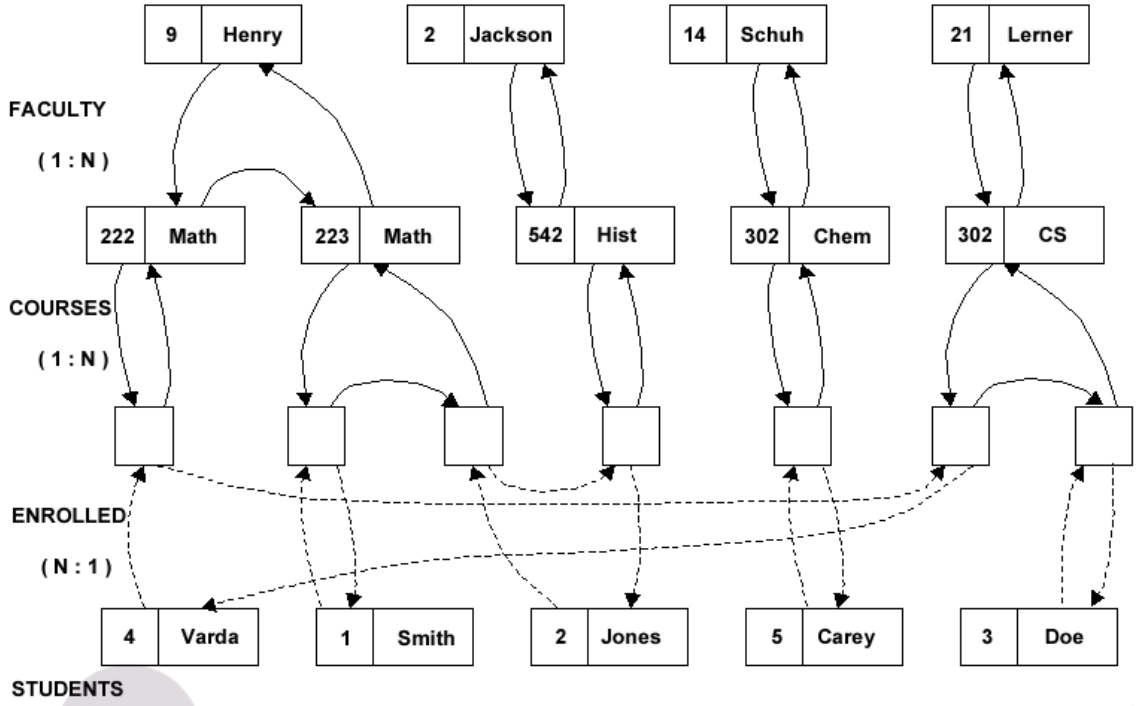
Flat File Model

	Route No.	Miles	Activity
Record 1	I-95	12	Overlay
Record 2	I-495	05	Patching
Record 3	SR-301	33	Crack seal

- A hierarchical database organizes its data at different levels and uses only the one to many association between levels.
- This simple example



- Based on the one to many association each level is divided into different branches.
- A network database with connection across table, as shown by the pages between the tables in figure.



- A common problem with both the hierarchical and the network database design is that the link pages between tables must be known in advance and built using the database at design time.
- This requirement tend to make a complicated and inflexible database and limit the database applications.
- A relational database is a collection of table, also called relations, which can be connected to each other by keys.

Student Relation

Sid #	Name	Year	GPA
1	Smith	3	3.0
2	Jones	2	3.5
3	Doe	1	1.2
4	Varda	4	4.0
5	Carey	4	0.5

Faculty Relation

Fid #	Name	Position	Dept
9	Henry	Prof.	Math
2	Jackson	Assist. Prof	Hist
14	Schuh	Assoc. Prof	Chem
21	Lerner	Assist. Prof	CS

Course Relation

Course #	Course Name	Cr	Dept
223	Calculus	5	Math
302	Intro Prog	3	CS
302	Organic Chem	3	Chem
542	Asian Hist	2	Hist
222	Calculus	5	Math

Taught-By Relation

C #	Fid #	Dept
223	9	Math
222	9	Math
302	21	CS
302	14	Chem
542	2	Hist

Enrolled Relation

Sid #	C #	Dept
1	223	Math
4	222	Math
4	302	CS
3	302	CS
5	302	Chem
2	542	Hist
2	223	Math

- A primary key replaces one or more attributes whose values can identify a record in a table.
- Its counterpart is another table for the purpose of linkage is called a foreign key.
- Thus a key common to two tables can tablets connections between corresponding records in the table.
- In the key connecting zoning and parcel is the zone code and the key containing parcel and owner is the PIN.
- When used together, the key can relate zoning and owner.

Normalization

- Preparing a relational database involves following certain rules.
- An important rule is called normalization.
- Normalization is a process of decomposition, taking a table with all the attribute data and breaking it down into small tables while maintaining the necessary linkages between them.
- Normalization is designed to achieve the following objectives
  1. To avoid redundant data in table that waste space in the database and may cause data integrity problems
  2. To ensure that attribute data in separate tables can be maintained and updated separately and can be linked whenever necessary.
  3. To facilitate a distributed database.
- An example of normalization is offered here. Consider the image

PIN	Owner	Owner address	Sale date	Acres	Zone code	Zoning
P101	Wang	101 Oak St	1-10-98	1.0	1	residential
	Chang	200 Maple St				
P102	Smith	300 Spruce Rd	10-6-68	3.0	2	commercial
	Jones	105 Ash St				
P103	Costello	206 Elm St	3-7-97	2.5	2	commercial
P104	Smith	300 Spruce Rd	7-30-78	1.0	1	residential

- Table shows attributes data for a parcel map. The table contains redundant data: owner addresses are repeated for smith and residential and commercial zoning are entered twice.
- The table also contains uneven records depending on the parcel, the field of owner and owner address have either one or two values.
- An unnormalized table such as shown cannot be easily managed or edited.
- To begin with, it is difficult to define the field of owner and owner address and to store their values.
- A change of the ownership requires that all attribute data be updated in the table.
- The same difficulty applies to search option as adding or deleting values. Table 1 represent the first step in normalization .Often called the first normal form, table 2 no longer has multiple values in its cells, but the problem of data redundancy has increased.

PIN	Owner	Owner address	Sale date	Acres	Zone code	Zoning
P101	Wang	101 Oak St	1-10-98	1.0	1	residential
P101	Chang	200 Maple St	1-10-98	1.0	1	residential
P102	Smith	300 Spruce Rd	10-6-68	3.0	2	commercial
P102	Jones	105 Ash St	10-6-68	3.0	2	commercial
P103	Costello	206 Elm St	3-7-97	2.5	2	commercial
P104	Smith	300 Spruce Rd	7-30-78	1.0	1	residential

- P101 & P102 are duplicated except for changes of the owner and the owner address.
- Smith's address is included twice and the zoning description of residential and commercial are listed three times each.
- Also, identifying the owner address is not possible with PIN alone but requires a compound key of PIN and owner.
- Figure D represents the second step in normalization. In place of table 2 are three small tables of parcel, owner, and address.

Parcel table

PIN	Sale date	Acres	Zone code	Zoning
P101	1-10-98	1.0	1	Residential
P102	10-6-68	3.0	2	Commercial
P103	3-7-97	2.5	2	Commercial
P104	7-30-78	1.0	1	Residential

Owner table

PIN	Owner name
P101	Wang
P101	Chang
P102	Smith
P102	Jones
P103	Costello
P104	Smith

Address table

Owner name	Owner address
Wang	101 Oak St
Chang	200 Maple St
Jones	105 Ash St
Smith	300 Spruce Rd
Costello	206 Elm St

- PIN is the key relating the parcel and owner tables.
- Owner name is the key relating to the address and owner tables.
- The relationship between the parcel and address tables can be established through the keys of PIN and owner name. The only problem with the second normal form is data redundancy with the fields of zone code and zoning.

- The final step in normalization is presented in figure E. A new table, zone, is created to take care of the remaining data redundancy problem with zoning.

Parcel table

PIN	Sale date	Acres	Zone code
P101	1-10-98	1.0	1
P102	10-6-68	3.0	2
P103	3-7-97	2.5	2
P104	7-30-78	1.0	1

Address table

Owner name	Owner address
Wang	101 Oak St
Chang	200 Maple St
Jones	105 Ash St
Smith	300 Spruce Rd
Costello	206 Elm St

Owner table

PIN	Owner name
P101	Wang
P101	Chang
P102	Smith
P102	Jones
P103	Costello
P104	Smith

Zone table

Zone code	Zoning
1	Residential
2	Commercial

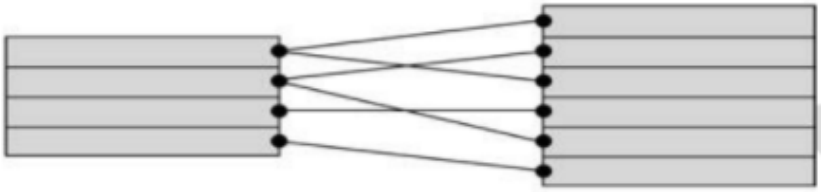
- Zone code is the key relating the parcel and zone tables.
- Unnormalized data in table 1 are fully normalized.
- Higher normal form can achieve objectives consistent with the relational model, but they can slow down data access and create higher maintenance cost.
- To find the addresses of parcel owners, for example, we must link three tables (parcel, owner and address) and employ to keys (PIN and owner name).
- One way to increase the performance in data access is to reduce the level of normalization by, for example removing the address table and including the addresses in the owner table.
- Therefore, normalizations should be maintained in the conceptual design of a database, but performance and other factors should be considered in its physical design.

Types of relationships

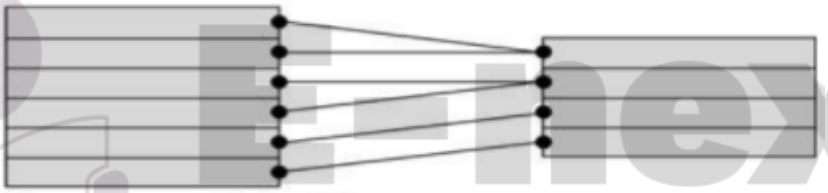
- A relational database may contain four types of relationships between tables or more precisely between records in tables.
    - One to one,
    - One to many,
    - Many to one
    - Many to many.
- The one to one relationship means that one and only one record in a table is related to one and only one record in another table.
- The one to many relationship means that one record in a table may be related to many records in another table.
- For example the street address of an apartment complex may include several households.

- The many to one relationship means that many records in table may be related to one record in another table.
- For example, several households may share the same street address.
- The many to many relationship means that many records in a table may be related to many records in another table.

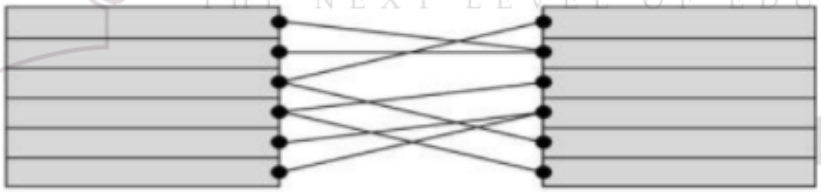
One-to-one relationship



One-to-many relationship



Many-to-one relationship



Many-to-many relationship

- For example, a timber stand can grow more than one species and a species can grow in more than one stand.
- To explain these relationships, especially one to many and many to one the designation of base table can be helpful.
- For example the purpose is to join attribute data from another table to a feature attribute table, then the feature attribute table is the base table and other table is a table to join.
- The feature attribute table has the primary key and other table has the foreign key.
- Often the designation of the base table depends on the storage of data and information sought.
- This is illustrated in the following two example .First example refers to the four normalized tables of parcel, owner, address, and zone in figure E.
- Suppose the question is to find who owns a selected parcel? To answer this question we can treat the parcel table as the base table and the owner table as the table to be linked.

- Relationship between tables is one to many. One record in the parcel may correspond to more than one record in owner table.
- Suppose the question is now changed to find land parcels owned by a selected owner?
- The owner table becomes the base table and parcel table is the table to be linked.
- The relationship is many to one: more than one record in the owner table may correspond to one record in parcel table. The same is true between the parcel table and the zone table.
- If the question is to find the zoning code for select parcel. It is many to one relationship. The question is to find land parcel that as zoned commercial, it is one to many relationship.
- Joining and relating tables. A relational database allows attribute data in separate tables to be linked whenever necessary.
- Two common operations for linking tables are join and relate. A join operation brings together two tables by using a key that is common to both tables.
- A typical example of join is to join attribute data from one or more non-spatial data tables to a feature attribute table.
- The joined table and attribute can then be used for data query and analysis.
- Join is usually recommended for one to one or many to one relationship.
- Given a one to one relationship, two tables are joined by record.
- Given a many to one relationship many records in the base table have the same value for a record in the other table.
- Join is appropriate with the one to many relationship because only the first matching record value from the other table is assigned to a record in the base table.
- A relate operation temporarily connects two tables but keeps the tables physically separate.
- We can connect three or more tables simultaneously by first establishing relates between tables in pair.
- One advantage of relate is that they are appropriate for all four types of relationships.
- This is important for data exploration and data query because a relational database is likely to include different types of relationships.
- But relates tend to slow down data access especially if the data reside in a remote database.

Attribute data entry

- Attribute data entry is like digitizing paper map.
- The process requires the setup of the fields to be entered, the choice of digitizing method and the verification of attribute values.

Field definition

- First step in attribute data entry is to define each field in the table. A field definition usually includes the field name, data-width, data type, and the number of decimal digits.
- The width refers to the number of spaces to be reserved for field. The width should be large enough for the largest number, including the sign, or the longest string in the data.
- The data type must follow data types allowed in GIS package.

Methods of data entry

- Data entry in GIS can be done by direct or indirect methods.
- Indirect method the data entry is borrowed from some agency in digital format.
- In indirect methods typing is only option.

Attribute data verification

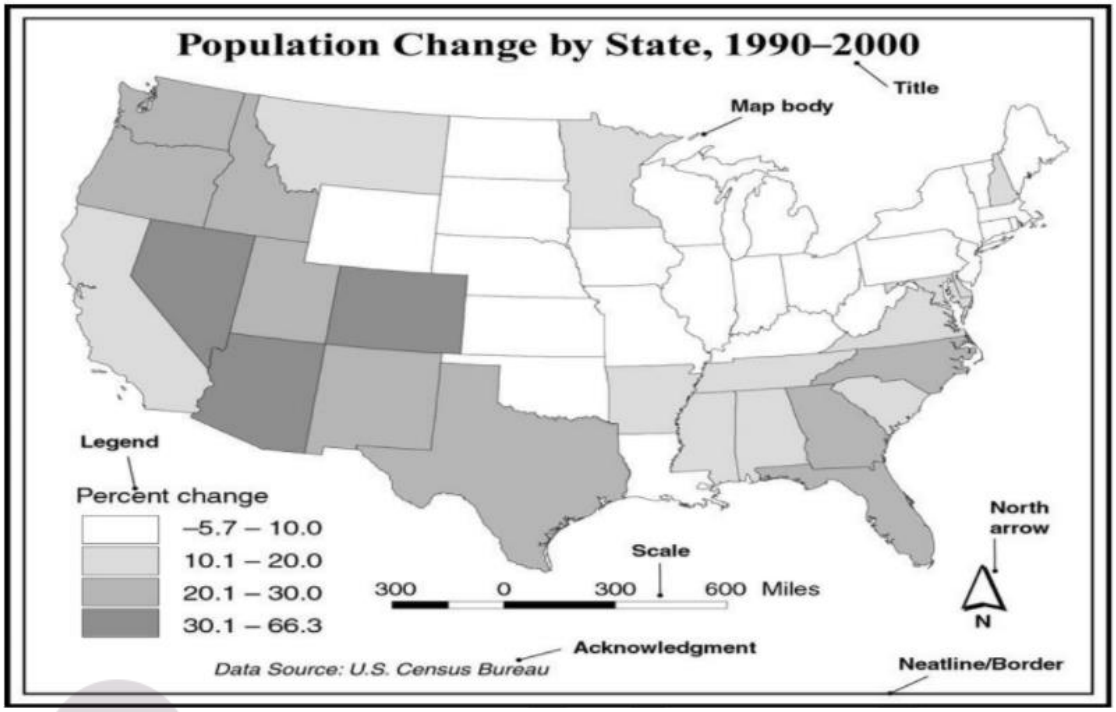
- Data verification has two steps.
- The first is to make sure that attribute data are properly linked to spatial data: the label or feature id should be unique and should not contain null values.
- Second step is to verify the accuracy of attribute data.
- There are at least two traditional methods for checking for data entry errors.
- First, attribute data can be printed for manual verification. This is like using check plots to check the accuracy of spatial data.
- Second computer program can be written to verify data Accuracy.

Manipulation of field and attribute data

- Database management tasks involves table as well as field and field value in tables.
- Field management includes adding or deleting fields and creating new attribute through classification and computation of existing attribute data.
- Adding and deleting fields adding field is required for the classification or computation of attribute data.
- The new field is designed to receive the result of classification or computation. To add a field, we must define the field in the same way as for attribute data entry.
- Classification of attribute data new attribute data can be created from existing data through data classification.
- Based on an attribute or attributes, data classification reduces a small data set to a small number of classes for example, elevations can be grouped into less than 500, 500 to 1000, and so on .
- Computation of attribute data new attribute data can also be created from existing data through computation.
- Operationally it involves two steps first define a new field and second computing a new field value from the values of an existing attribute or attributes.

Data display and cartography

- Maps are an interface to GIS. We view query, analyze maps. We plot the maps to examine the result of query and analysis and we produce maps for presentation and reports.

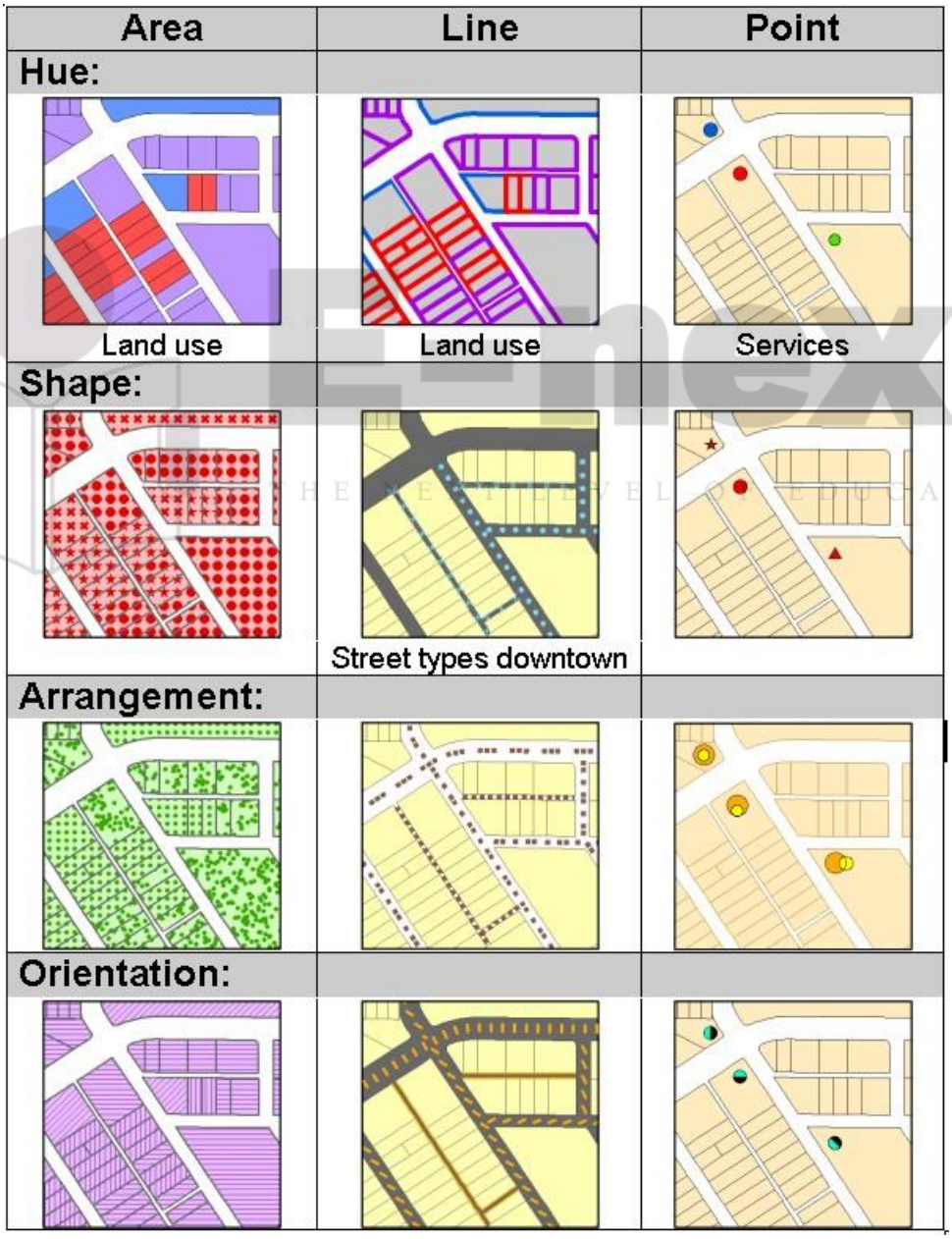


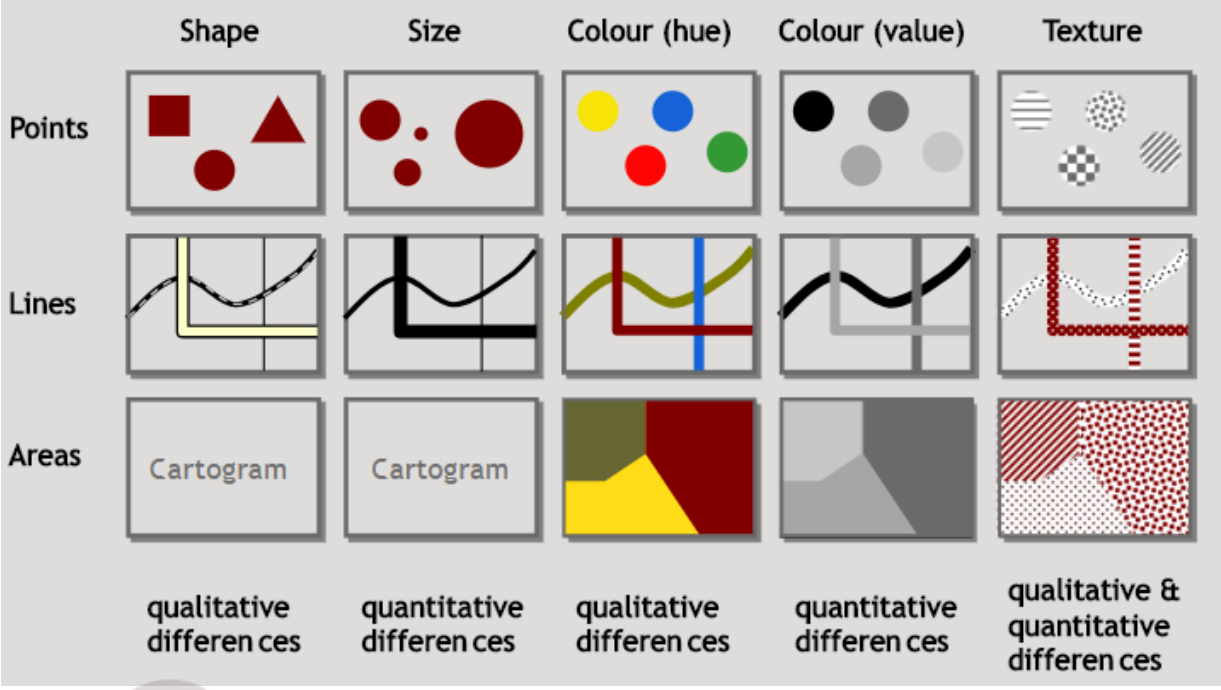
- Common map elements are the title, body, legend, north arrow, scale bar, acknowledgement and neat line / map border. Other elements include the graticule or grid, name of map projections, inset or location map, and data quality information, these elements bring the map information to the map readers.
- The map body is most important part map it contains the map information.
- The elements of the map support the communication process for example, title suggest a subject matter and legend relates map symbols to mapped data.
- In practical terms, map making may be described as a process of assembling map elements.
- Data display is one area in which commercial GIS packages have greatly improved. GIS packages with graphical user interface are excellent for data display for 2 reasons.
- First, the map maker can simply point and click on the graphic icons to construct map. In comparison, a command line driven package requires the user to become familiar with many commands and their parameters making a map
- Second, desktop GIS packages have incorporated some design options such as symbol choices and color schemes into menu selection.

Cartographic symbolization

- Cartography is the making of and study of maps in all their aspects.
- Basic element of cartography is symbolization, the use of different map symbols to represent spatial features and map symbols.
- Spatial features are characterized by their locations and attributes .To display a spatial data feature on map, we use maps symbol to indicate the features location and visual variables with the symbol to show the features attribute data.
- The choice of map symbol is simple for raster data: the map symbols applies to cells whether the spatial feature to be depicted is a point, line, or area.

- The choice of map symbols for vector data depends on the features type. The general rule is to use point symbols for point Features, line symbols for line features, and area symbols for area features.
- But this general rule does not apply to volumetric data or aggregate data. There are no volumetric symbols for data such as division, temperature, and specification.
- Instead, 3D surfaces and isolines are often used to map volumetric data. Aggregate data such as county populations are data reported at and aggregate level.
- A common approach is to design an aggregate data to the center of each county and display the data using Symbols.
- Visual variables for data display include hue, value, Chroma, size, texture, shape, and pattern.





- The choice of visual variable depends on the type of data to be displayed. The measurement scale is commonly used for classifying attribute data.
- Size and texture are more appropriate for displaying ordinal, interval and ratio data.
- For example, a map may use different circles to represent different size cities.
- Shape and pattern are more appropriate for displaying nominal data. For example, a map may use different area patterns to show different land use types.

Use of color

- Because color adds a spatial appeal to a map, mapmakers will choose color maps over black and white maps whenever possible.
- Color is probably the most misused visual variable.
- Hue is the quality that distinguishes one color from another, such as read from blue.
- Hue can also be defined as the dominant wavelength of light making up a color which tend to relate different hues with different kinds of data.
- Value is the lightness or darkness of color, with black at the lower end and white at the higher end.
- We generally perceive symbols on map as being more important, or greater in terms of magnitude.
- Chroma refers to the richness, or brilliance, of a color.
- A fully saturated color is pure, whereas a low saturation approaches gray.
- We generally associate higher intensity symbols with greater visual importance.
- The first rule of thumb is the use of color is simple: hue is a visual variable better suited for qualitative data.
- Whereas value and Chroma are better suited for quantitative data.
- Qualitative mapping is relatively easy. It is not difficult to find 12 or 15 distinctive hues for a map.

- If a map requires more symbols we can add pattern or text to hue to make up more map symbols.
- Quantitative mapping has received much more attention than qualitative mapping.
- Over the years, cartographers have suggested general color schemes that combined value and Chroma for displaying quantitative data.
- The following is a summary of the color schemes

The single hue scheme

- This color scheme uses a single you whereas the combination of value and Chroma to produce a sequential color scheme such as from light red tube dark red .It is a simple but effective use of for displaying quantitative data .

The hue and value scheme.

- This color scheme progresses from a light value of one hue to dark value of different hue. Examples are yellow to dark red and yellow to dark blue.

The diverging and double ended scheme.

- This color scheme uses graduated colors between two dominant colors. For example, a diverging scheme may progress from dark blue to light blue and then from light red to dark red.

The part spectral scheme

- This color scheme uses adjacent colors of the visible spectrum to show variations in magnitude. Examples of this color scheme includes yellow to orange to red and yellow to green to blue.

The full Spectral scheme

- This color scheme uses all colors in the visible spectrum. A conventional use of the full spectral keep is found in elevation maps. Cartographers usually do not recommend this option for mapping other quantitative data because there is no logical sequence between hues.

Data classification

- Data classification involves the use of classification methods and a number of classes for aggregating data and map features. A GIS package typically offers different data classification methods. The following summarizes five commonly used methods:
- **Equal interval:** This classification methods divides the range of data values in equal intervals.
- **Equal frequency:** Also called quantile, this classification method divides the total number of data values by the number of classes and ensures that each class contains the same number of data values.
- **Mean and standard deviation**: This classification method sets the class breaks at units of the standard deviation (0.5, 1.0 etc.) above or below the mean.
- **Natural breaks**: Also called the chain optimization method, this classification method optimizes the grouping of data values. The methods uses computing algorithm to

minimize differences between data values in the same class and to maximize differences between classes.

- **User defined**: This method lets the user choose the appropriate or meaningful class breaks. For example, in mapping rates of population change by state, the user may choose 0 or the national average as a break.

Types of maps:-

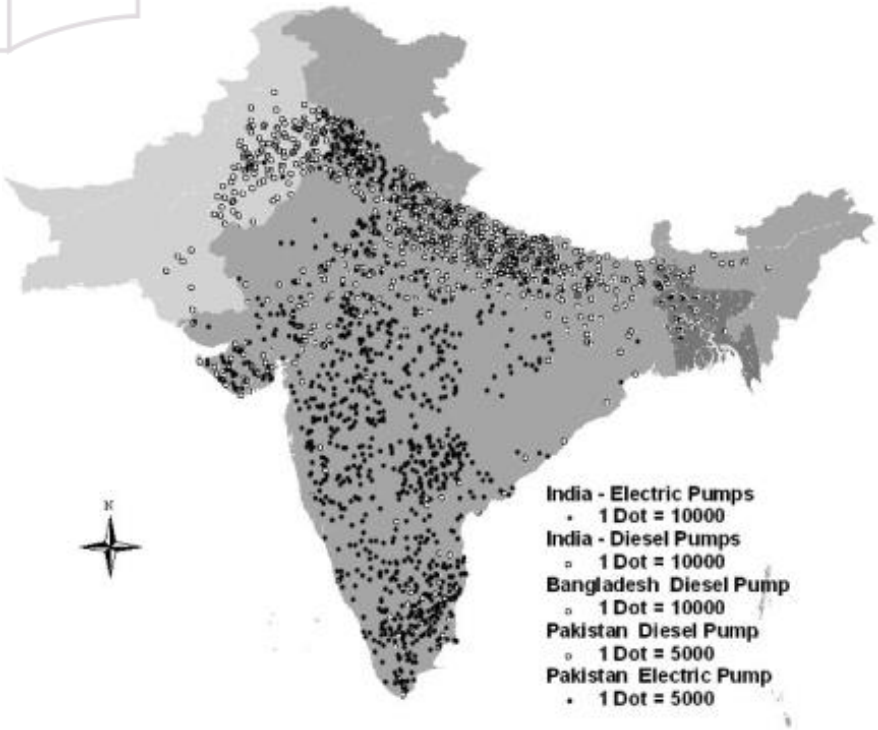
- Cartographers classify maps by function and by symbolization.
- By function, maps can be general reference or thematic.
- The general reference map is used for general purposes.
- Thematic map, also called the spatial purpose map because its main objective is to show the distribution pattern of a theme, such as the distribution of population densities by a county in a state.
- By map symbol, map can be qualitative or quantitative.
- Qualitative map uses visual variables that are appropriate for portraying qualitative data.
- Whereas a quantitative map uses visual variables that are appropriate for communicating quantitative data.
- The following describes several common types of quantitative maps.

1. The dot Map:

o Uses uniform point (.) Symbols to show spatial data with each symbol representing a unit value.

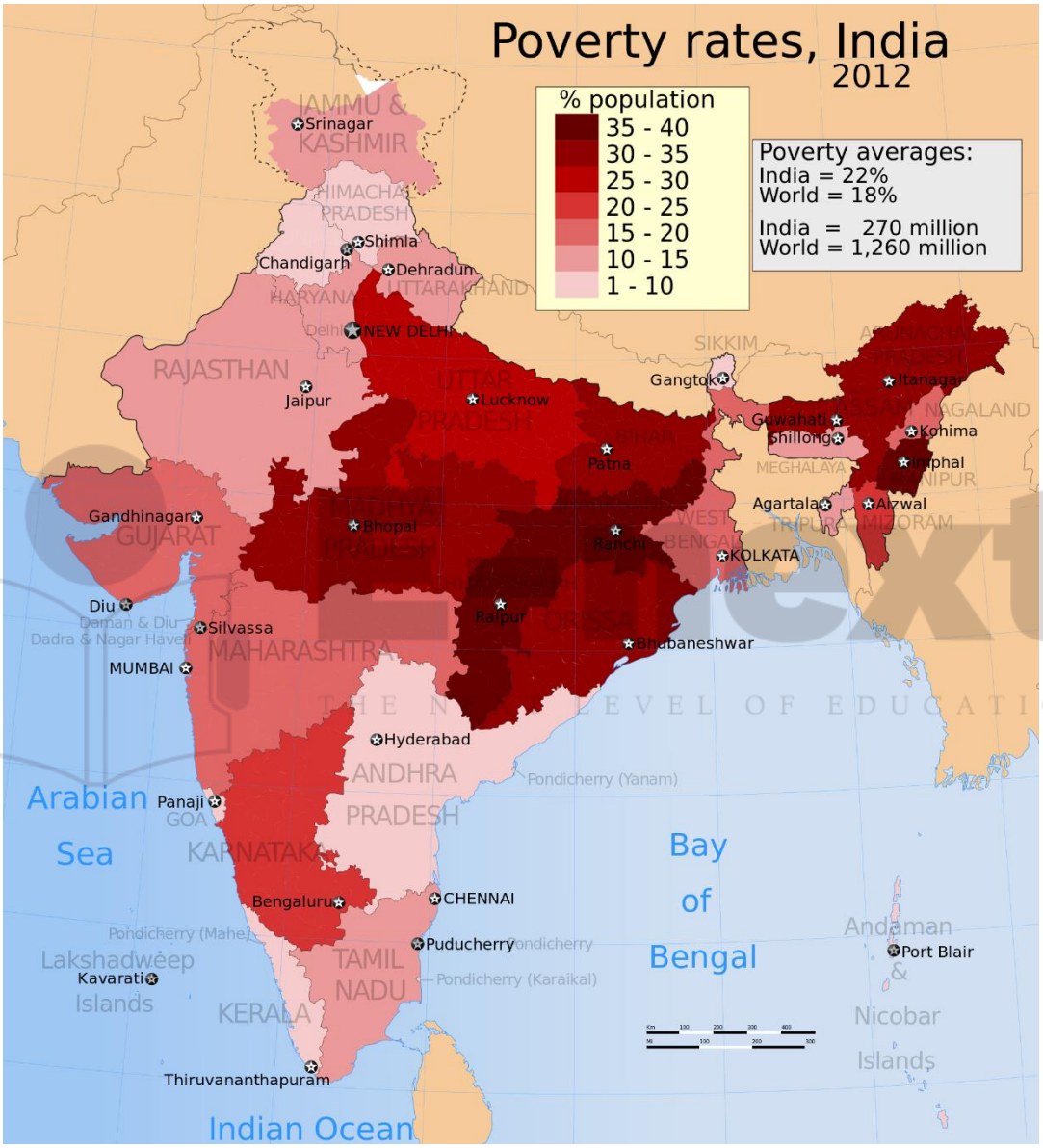
o One to one dot mapping uses the unit value of one, such as one representing one crime location.

o But in most cases, it is one to many mapping and the unit value is greater than one.



2. The choropleth map:-

o The choropleth map symbolizes, with shading, derived data based on administrative units. An example is a map showing average household income by county. The derived data are usually classified prior to mappingand are symbolized using a color scheme for quantitative data.

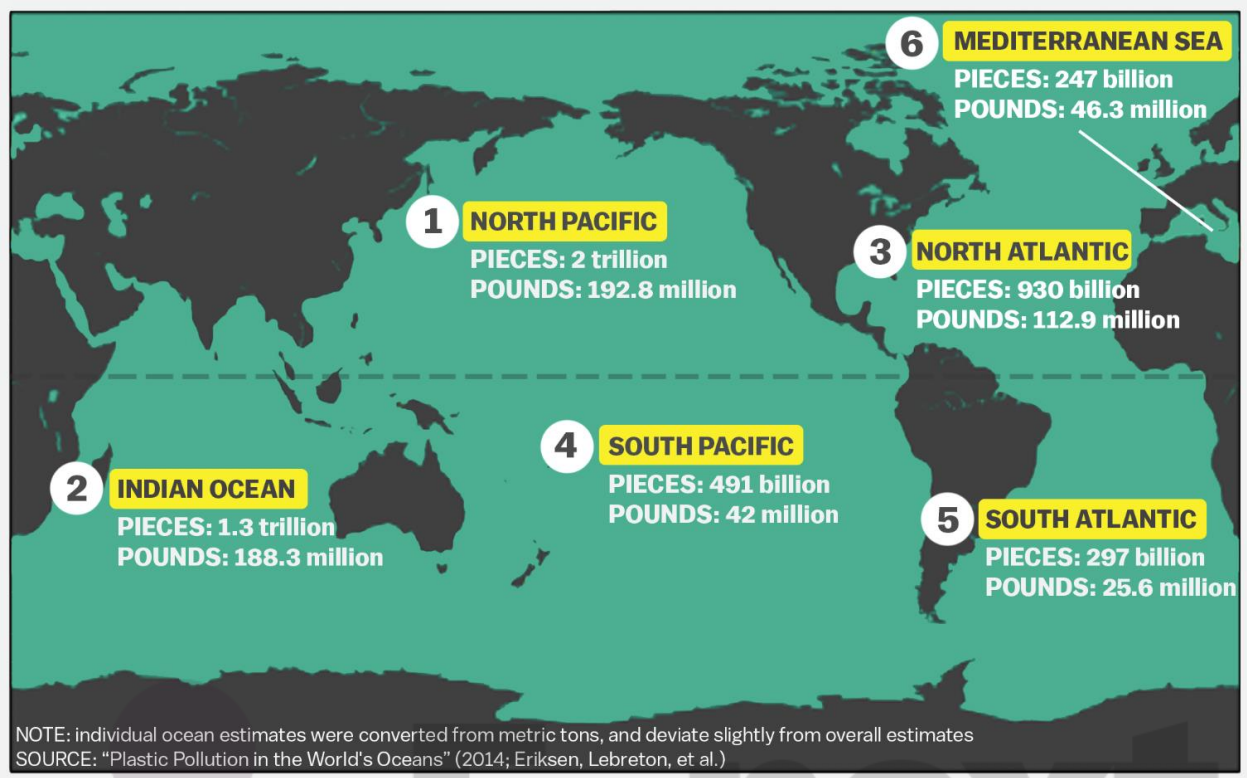


3. The daisy metric

o The daisy metric map is a variation of the simple choropleth map.

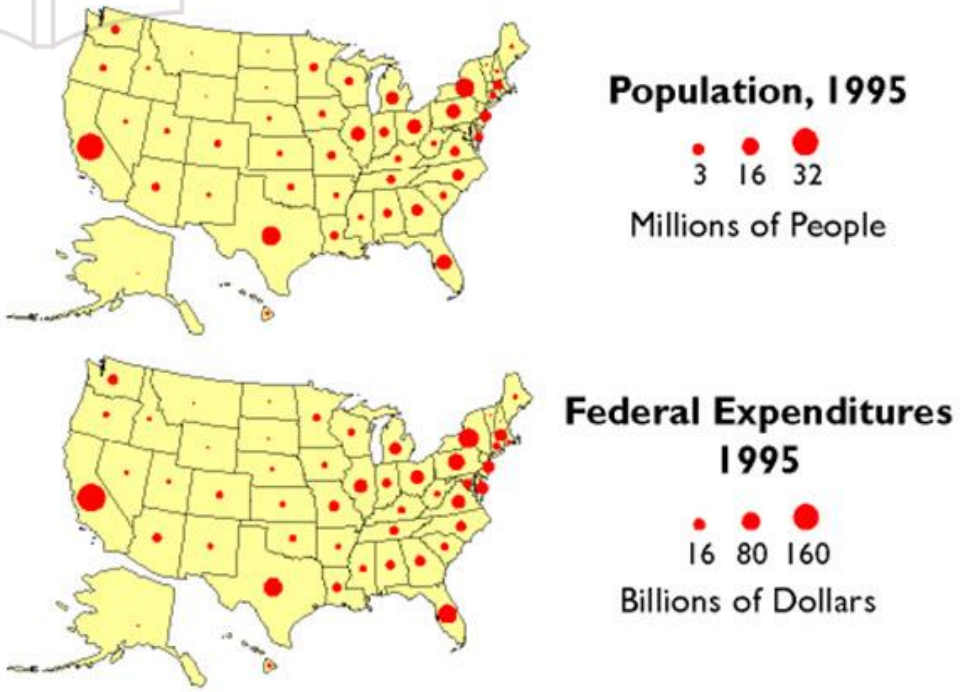
o By using statistics and additional information, the daisy metric map delineates area of homogeneous values rather than following administrative boundaries.

o A GIS package such has ArcGIS uses the term gratitude color map to cover the choropleth map and daisy metric maps because both map types use a graduate color scheme to the variation in spatial data.



4. The graduated symbol map

o The graduated symbol map uses different sized symbols such as circles, squares, triangles to represent different range of values. For example, we can use graduated color symbols to represent cities of different population ranges.



5. The Proportional symbol map

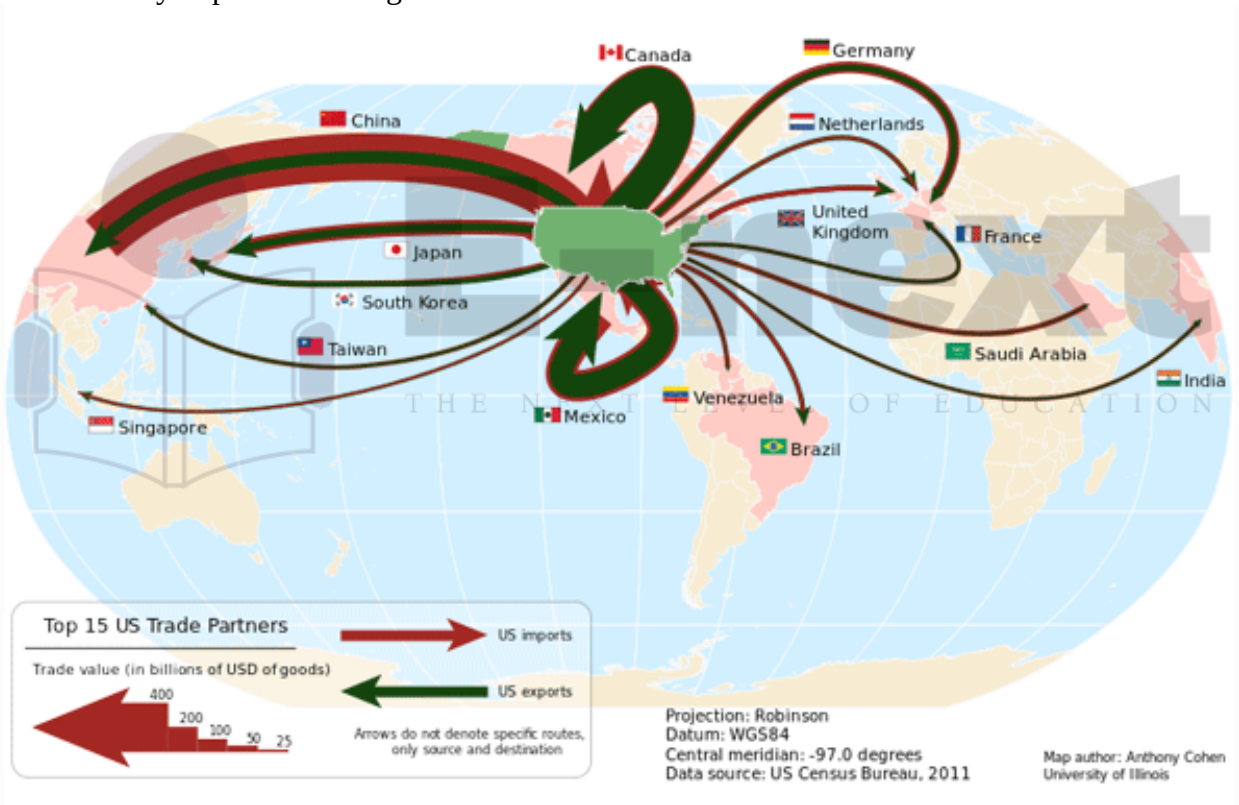
o Proportional symbol map is a map that uses a specific small size for each numeric value rather than a range of values. Therefore one circle size may represent a population of 10000, another 15000 and so on.

6. The chart map

o The chart map uses a pie charts or bar charts. A variation of graduated circle, the pie chart can display two sets of quantitative data, the circle size can be made proportional to a value such as a county population, and the sub divisions can show the makeup of the value.

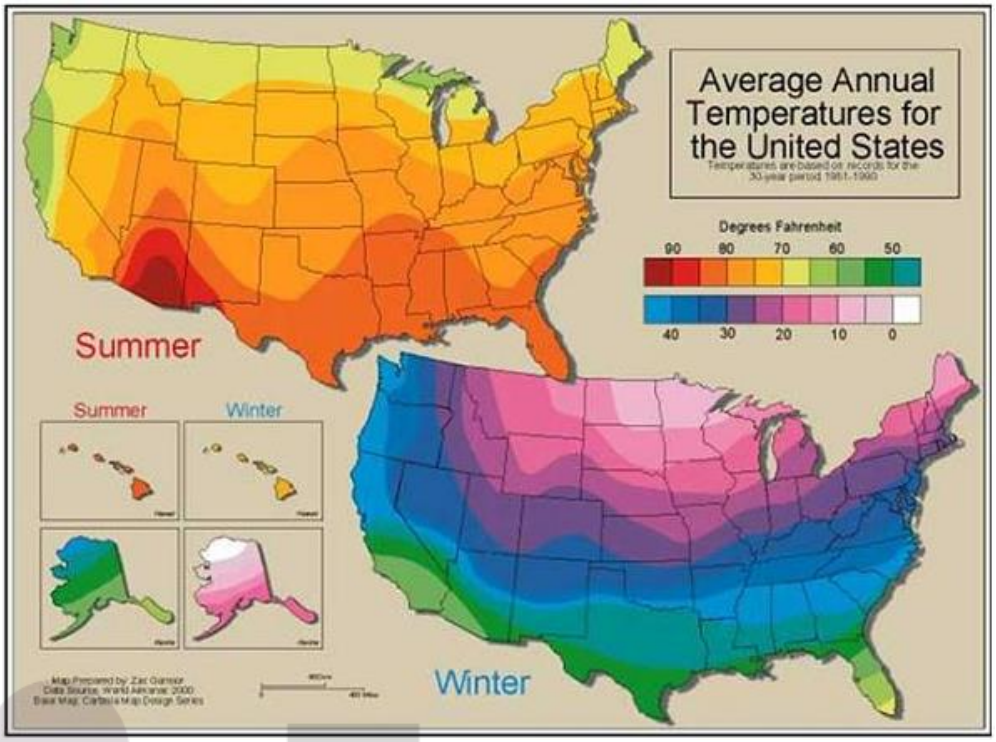
7. Flow map

o Flow map displays different quantities of data such as traffic volume and stream flow by varying the line symbol width. Similar to the graduated symbols the flow symbols usually represents a range of values.



8. The isarithmic map

o Isarithmic map uses a system of isolines to represent a surface.



Typography

- A map cannot be understood without text on it.
- Text is needed for almost every map element. Mapmakers treat text as a map symbols because like point, line, or area symbols, text can have many type variations. Using type variation to create a pleasing and coherent map is therefore part of the map making process.

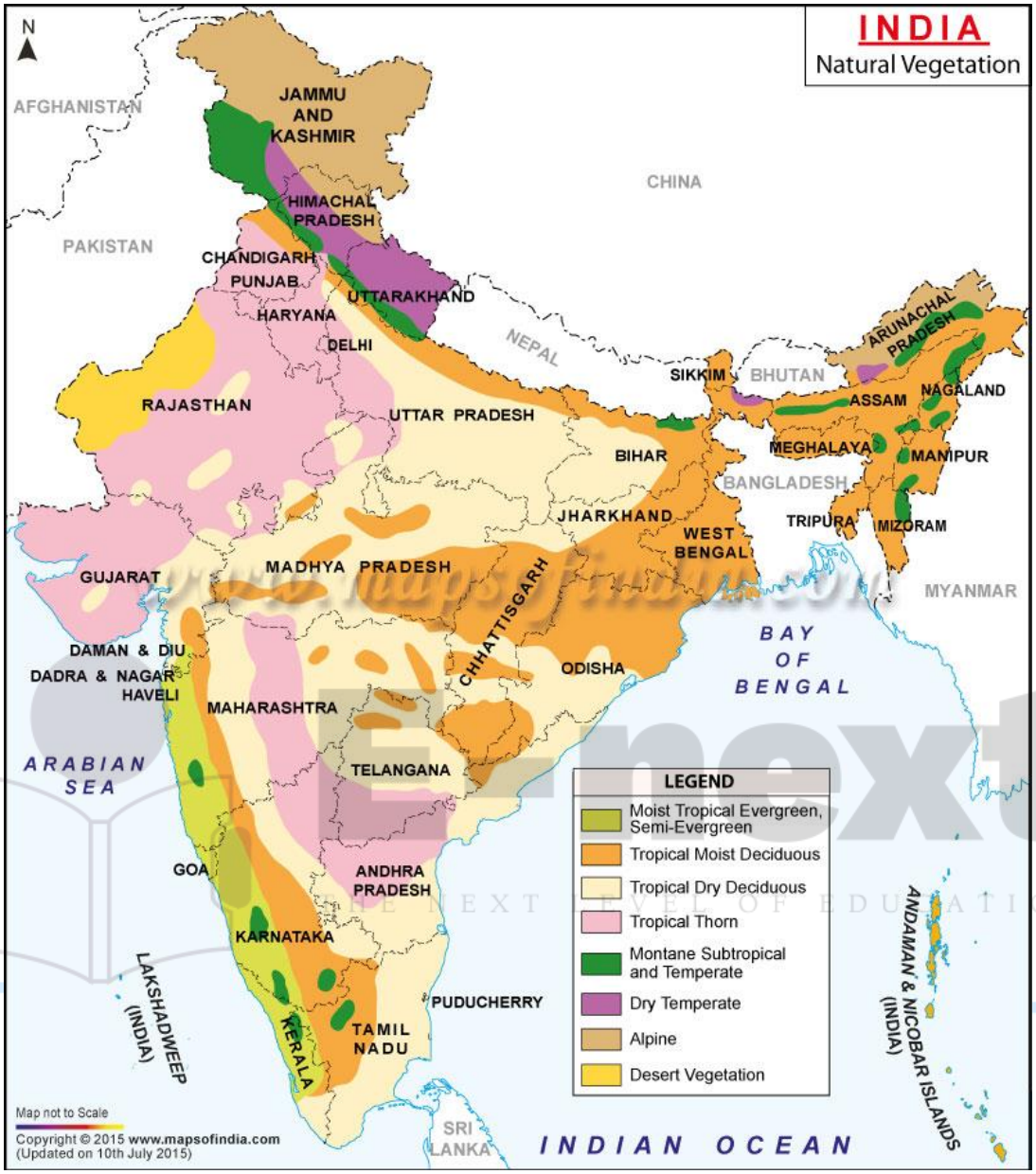
Type variations

- Type can vary in typeface and form.
- Typeface refers to the design character of the type.
- Two main groups of typefaces are serif and sans serif.
- The first one with serif and last without serif. Serif are small, finishing touches at the end of line strokes, which tend to make running text in newspapers and books easier to read.
- Compared to serif types san serif types appears simpler and bolder.
- Type form variations include type weight (bold, regular or light), type width (condensed or extended), upright vs. slanted (or roman vs. italic) and uppercase vs. lower case.
- A Font is a complete set of all variants of a given typeface.
- Type can also vary in size and color type size measure the height of a letter come up with 72 points to an inch. Figure

New Bodoni DT Book
New Bodoni DT Book Italic
New Bodoni DT Regular
NEW BODONI DT SC OSF REGULAR
New Bodoni DT Italic
NEW BODONI DT SC OSF TALIC
New Bodoni DT Bold
NEW BODONI DT SC OSF BOLD
New Bodoni DT Bold Italic
NEW BODONI DT SC OSF BOLD ITALIC
New Bodoni DT Extra Bold
New Bodoni DT Extra Bold Italic
New Bodoni DT Black
New Bodoni DT Black Italic

Selection of type variations

- Type variations for text symbols can function in the same way as visual variables for map symbols.
- A practical guidelines is to group text symbols into qualitative and quantitative classes.
- Text symbols representing qualitative classes such as names of streams, mountains, park, and so on can vary in typeface, color, and upright vs. italic.
- In contrast, text symbols representing quantitative classes such as names of different size cities can vary in type size, weight and uppercase vs. lower case.
- Grouping text symbols into classes simplifies the process of selecting type variation.
- Besides classification, cartographers also recommend legibility, harmony and conventions for type selection.
- Legibility is difficult to control on a map because it can be influenced not only by type variation but also by the placement of text and the contrast between text and the background symbol.
- Type legibility should be balanced with harmony. As a means to communicate the map content, text should be legible but should not draw too much attention.
- Mapmakers can generally achieve harmony by adopting only one or two typefaces on a map.



Placement of Text in map body

- Text elements in the map body also called labels are directly associated with the spatial features.
- In most cases, these labels are name of spatial features. But they can also be some attribute value such as contour reading or precipitation amounts.
- As a general rule, label should be placed to show the location for the area extent of the named spatial feature.
- Cartographers recommend placing the name of a point feature to the upper right of its symbols, the name of a line feature in a block and parallel to the course of the feature, and the name of an area feature in a manner that indicates its area extent.

- Automated name placement presents several difficult problems for the computer programmer: names must be legible, names cannot overlap other name, names must be clearly associated with their intended referent symbols and name placement must follow cartographic conventions.
- These problems worsen as smaller map scales as competition of the map space intensifies between names.

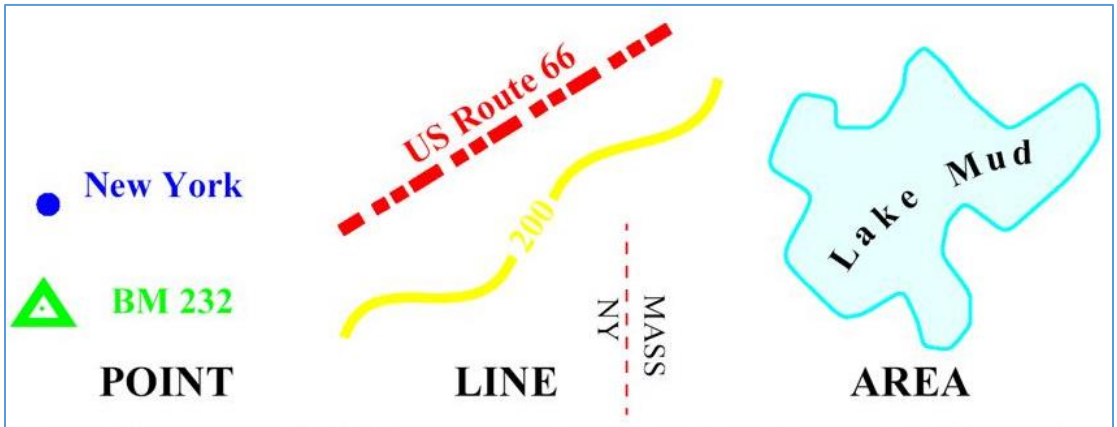
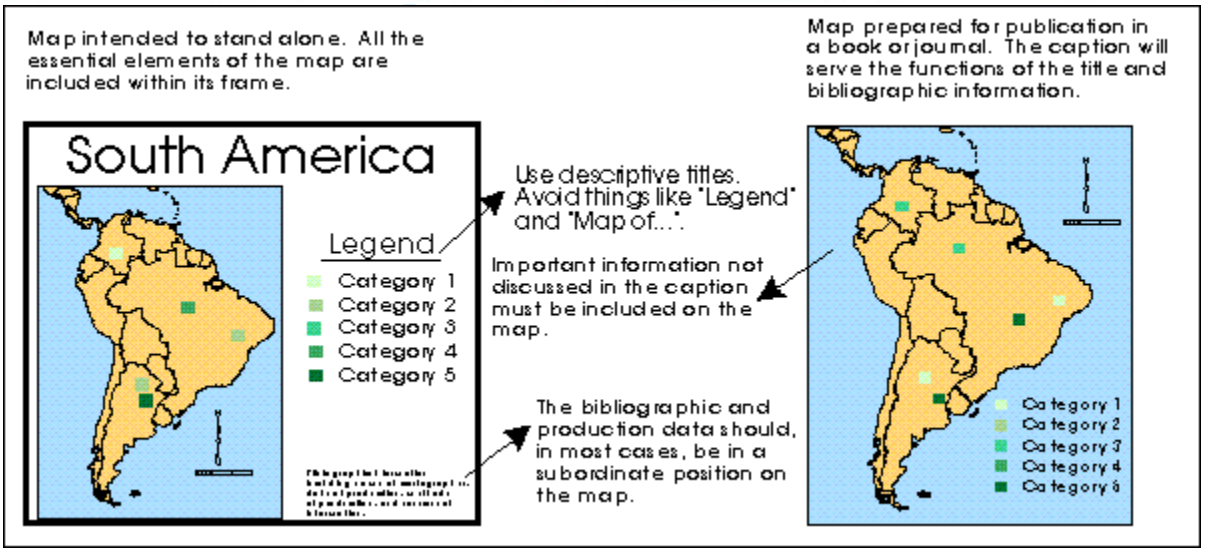
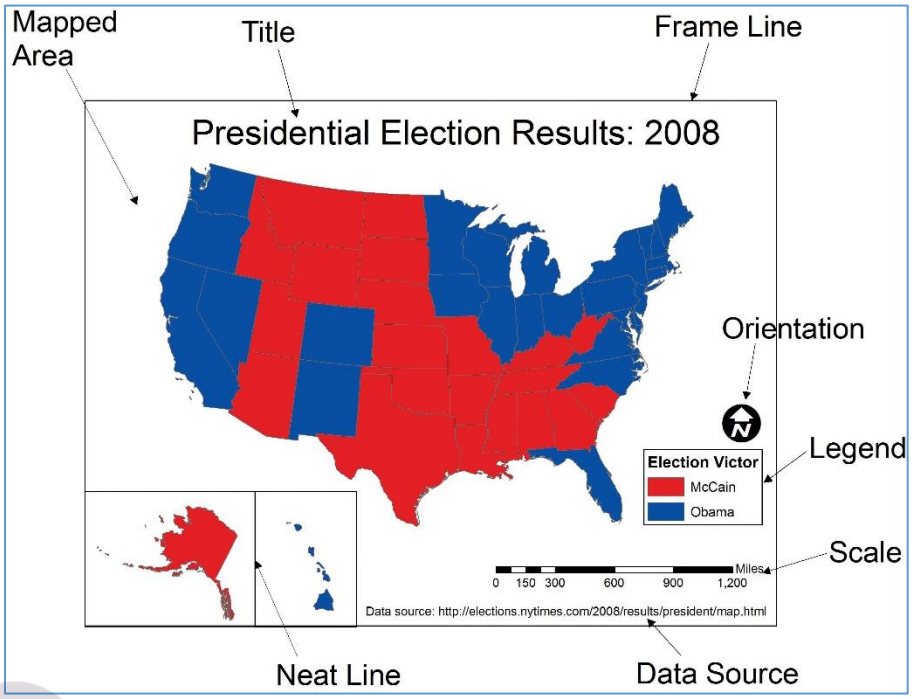


Figure 7.2 Some cartographic label placement conventions. Points: right and above preferred with no overlap. Lines: Following the direction of the line, curved if a river. Text should read up on the left of the map and down on the right. Areas: On a gently curved line following the shape of the figure and upright.





Map design

- Like graphic design, map design is a visual plan to achieve a goal. The purpose of map design is to enhance map communication which is particularly important for thematic maps.
- Well-designed map is balanced, coherent, ordered and interesting to look, whereas a poorly design map is confusing and disoriented.
- There may not be the right or wrong design for maps, but there are better or more effective maps and worse or less effective maps.
- Cartographers usually study map design from the perspective of layout and visual hierarchy.

Layout

- Layout or planar organization deals with the arrangement and composition of various map

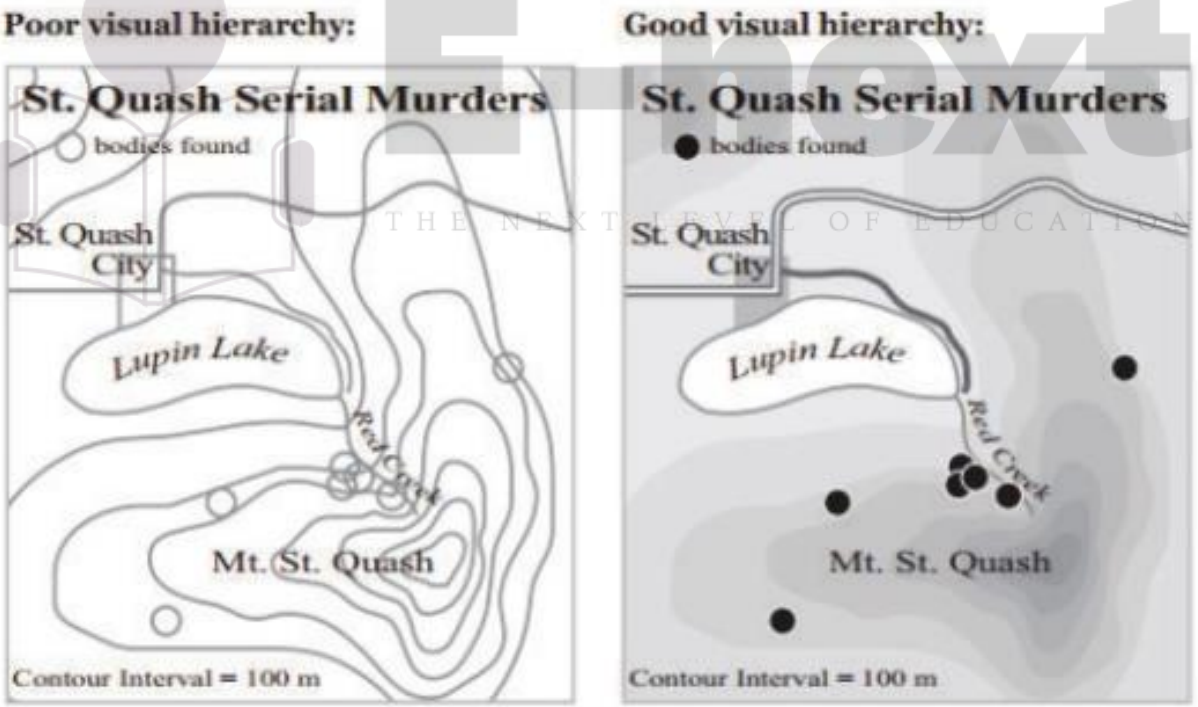
elements.

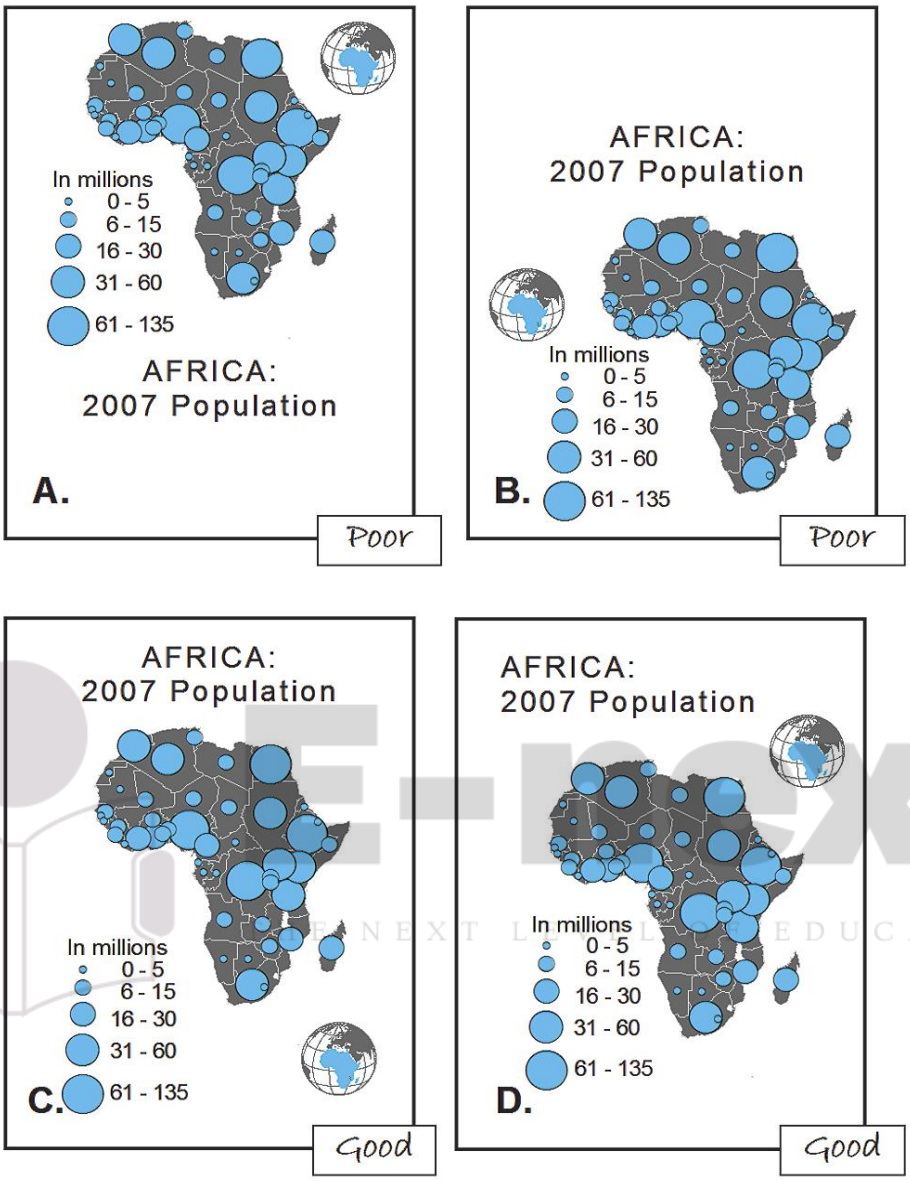
- Major concerns with layout are focus, order and balance.
- A thematic map have a clear focus, which is usually the map body or a part of my body.
- To draw the map reader's attention, the focal element should be placed at the optical center just above the maps geometric center.
- The focal element should be differentiated from other map elements by contrast in line width, texture, value, detail and color.
- After viewing the focal element, the reader should be directed the rest of the map in an ordered fashion.
- For example, the legend the title are probably the next element that the way you need to look at after the map body.

- To smooth the transition, the mapmaker should clearly place the legend and the title on the map with perhaps a box around the legend and a larger type size for the title to draw attention to them.
- A finished map should look balanced.
- It should not give the map reader an impression that the map looks heavier on the top, or bottom or a side.
- But balance does not suggest the breaking down of the map elements and placing them, almost mechanically, in every part of the map.
- Although in that case the elements would be in balance, the map would be disorganized and confusing.
- Map maker therefore should deal with balance within the context of organization and map communication.
- Regardless of the methods used in the layout design the legend deserves special consideration.
- The legend includes description of all the layers that make up a map.

Visual Hierarchy

- Visual Hierarchy is the process of developing a visual plan to introduce the 3d effect or depth to the map.

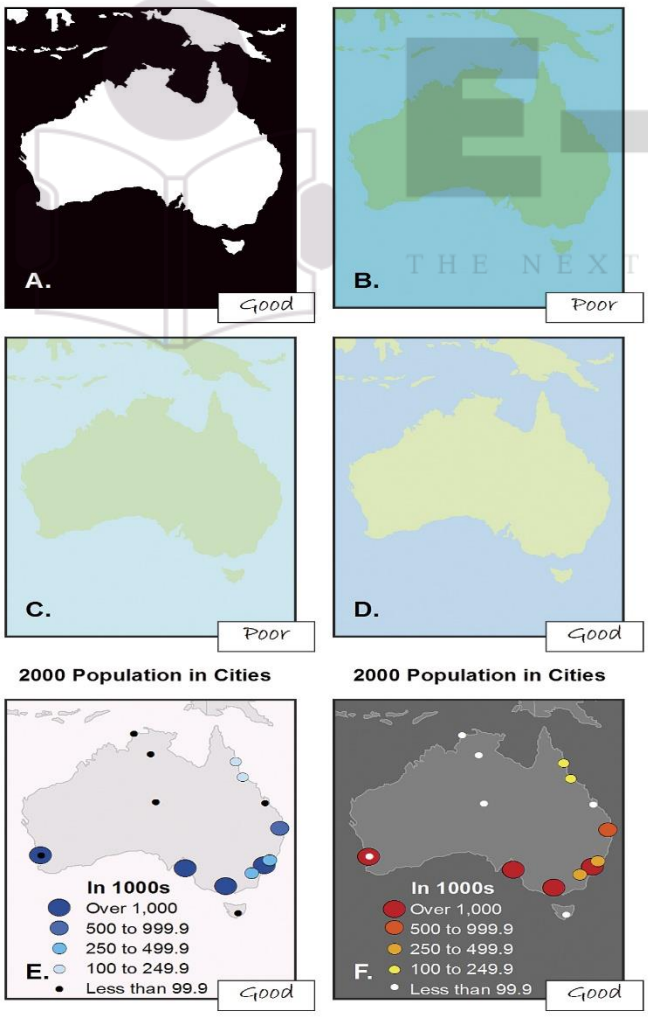




- Map makers create the visual hierarchy by placing map elements at different visual levels according to their importance to the maps purpose.
- The most important element should be at the top of visual hierarchy and it should appear closest to the reader.
- The least important element should be at the bottom.
- Thematic map may consist of three or more levels in a visual hierarchy.
- The concept of visual hierarchy is an extension of the figure ground relationship in visual perception.
- The figure is more important, appears closer to the viewer, has form and shape, has more impressive color and has meaning.
- The ground is the background.
- Cartographers have adopted the depth cues for developing the figure ground relationship in map design.

- Probably the simplest and yet most effective principle in creating visual hierarchy is interposition or superposition.
- Interposition uses the incomplete outline of an object to make it appear as which is behind another.
- Example of interposition abound in maps, especially in newspapers and magazines.
- Continents on a map look more important or occupy a higher level in visual hierarchy if the lines of latitude and longitude stop at the coast.
- Subdivisional organization is a map design principle that groups map symbols at the primary and secondary level according to the intended visual hierarchy.
- Each primary signal is given a distinctive hue and the differentiation among the secondary symbols is based on color variation, pattern or texture.
- For example, all tropical climates on climate map are shown in red and different tropical climates are distinguished by different shades of red.
- Sub divisional organization is most useful for maps with many map symbols, such as climate, soil, geology and vegetation maps.

Contrast



- Contrast is the basic element in map design, important to layout as well as to visual hierarchy.
- Contrast in size or width can make a state outline look more important than county boundaries and largest cities look more important than smaller ones.
- Contrast in color can separate the figure from the ground.
- Cartographers often use of warm color for the figure and a cool color for ground.
- Contrast in texture can also differentiate between figure and ground because the area containing more details or greater amount of texture tend to stand out on map.
- Like the use of interposition, too much contrast can create a confusing map appearance.
- Tool that many GIS packages offer for data display is called transparency. Which controls the percentage of layer that is transparent.
- Transparency can be useful in creating of visual hierarchy by "toning

down" down the symbols of a background layer.

Map production

- GIS user design and make maps on computer screen.
- These softcopy maps can be used in a variety of ways. They can be printed, exported to use on the Internet, used in or computer projection systems, exported to other software packages, or further processed for publishing.
- Map production is a complex topic. We are often surprised that color symbols from the color printers do not exactly match those on the computer screen.
- This discrepancy results from the use of different media and color models.
- Data display on the computer screen uses either CRT or LCD (liquid crystal display).
- It used to be that desktop computers used CRT or laptop or portable computers used LCDs.
- But now more text of computers are also using LCD to take advantage of the thin, flat screen.
- A CRT screen has a built-in fine mesh of pixels and each pixel has colored dots called phosphors.
- When struck by electron from an electron gun a dot slightly lights up and slowly grows dim.
- An LCD screen uses two sheets of polarizing materials which a liquid crystal solution between them.
- Each pixel on an LCD screen can be turned on or off independently.
- Besides being thinner and lighter, LCD screens have two other advantages over CRT screen.
- They consume less power and they produce sharper, flicker free images.
- With either a CRT or an LCD a color symbol we see on a screen is made of pixels and color of each pixel is a mixture of RGB (red, green, blue) 256 states. Combining the three primary colors produces a possible palette of 16.8 million colors 256*256*256.